Options Markets: Introduction

Chapter 20

Option Contracts

- **_call option_** = contract that gives the holder the right to _purchase_ an asset at a specified price, on or before a certain date
- **_put option_** = contract that gives the holder the right to _sell_ an asset at a specified price, on or before a certain date
- key feature: the holder is _not_ required to exercise the option, but can _choose_ to do so or not ➔ the holder has to pay for this right
- the holder has a _long_ position in the option, the seller of the option has the _short_ position

Key Elements of Options

- *exercise* (*strike*) *price* = the price at which the asset is traded when the option is exercised
- *expiration date* = the last date the option can be exercised on
- *premium* = purchase price of option (paid when the option is purchased, regardless of whether the option is exercised or not)
- *writer* = person initially selling the option
- *American option* = the holder can exercise the option any time *on or before* the expiration date
- *European option* = the holder can exercise the option *only* on the expiration date

"Moneyness"

- *in the money* = the option is worth exercising
- *out the money* = the option is not worth exercising
- *at the money* = the holder is indifferent between exercising the option or not
- the moneyness of an option is given by the relationship between the exercise price and the current price of the stock and the type of option
- moneyness is not related to *positive* profits, but to whether the option is exercised or not

Underlying Assets

- stock options are the common options
- *index options* = options based on the value of an index ➔ the execution is done by cash settlement
- *futures options* = the holder has the right to buy or sell a specified futures contract, with the price of the futures as exercise price
- *foreign currency options* = the holder can buy or sell a certain sum of foreign currency for a certain sum of domestic currency
- *interest rate options* = options based on debt securities

Call Options

- Value at expiration (payoff)
  - a call option will be executed only if the exercise price is lower than the ongoing price of the stock
  - hence, the value of the option at expiration is

$$\text{Payoff to call holder} = \begin{cases} S_T - X, & \text{if } S_T > X \\ 0, & \text{if } S_T \le X \end{cases}$$

where S_T is the "current price" of the stock, and X is the exercise price

Call Options (cont.)

- **Moneyness**
  - a call option is
    - *in the money* – if the exercise price is below the current price
    - *out the money* – if the exercise price is above the current price
    - *at the money* – if the exercise price is equal to the current price

Call Options (cont.)

- **Profits**
  - for the holder of the call option, the net profit is

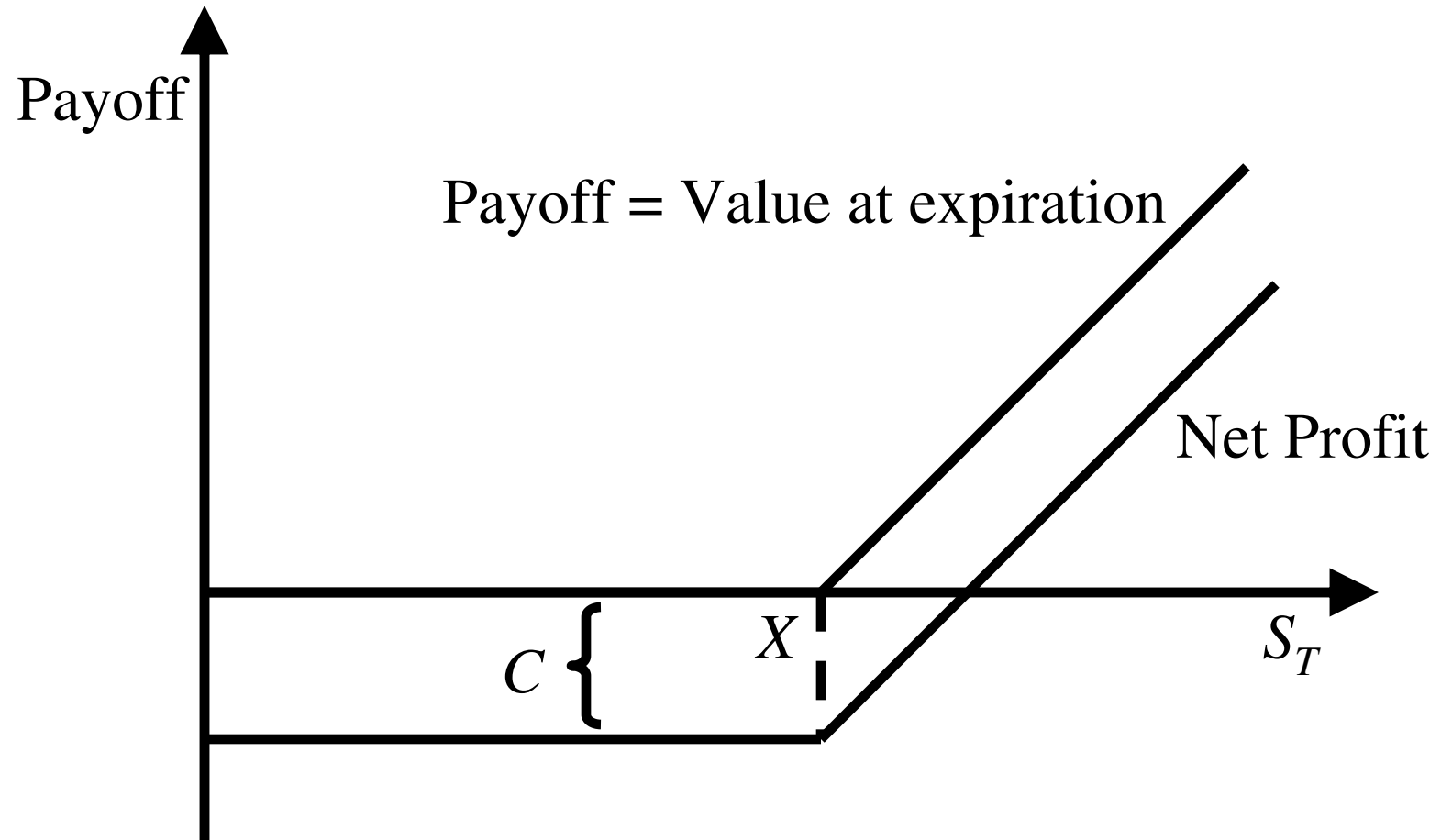 $$\text{Profit} = \text{Value at expiration} - \text{Premium } (C)$$

  - notice that the holder might not get positive profit even if the option is exercised
  - for the writer of the call option, the value at expiration and net profit are exactly the opposite those of the holder

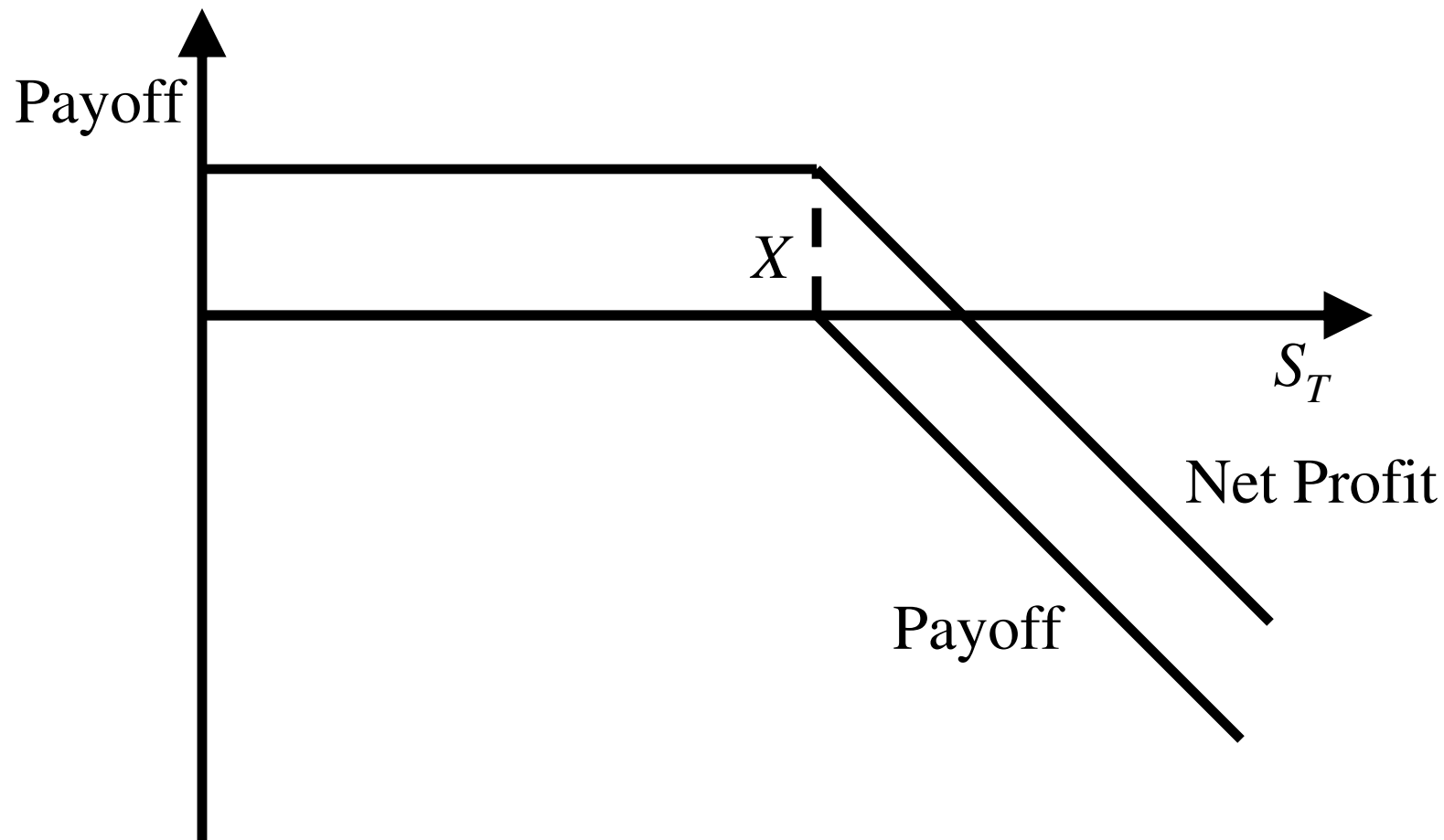 $$\text{Profit of writer} = -\text{Profit of holder}$$

  - writing a *naked call* (i.e., a call option without an offsetting position in the stock) exposes the investor to unlimited losses if stock price rises

Call Options – Holder

Payoff

Payoff = Value at expiration

Net Profit

C {

X

S_T

Call Options – Writer

Payoff

X

S_T

Net Profit

Payoff

Call Options – Example

- strike price: $X = \$100$
- premium: $15

Value of stock (S_T)	Payoff	Profit for holder	Profit for writer
$90	$0	–$15	$15
$100	$0	–$15	$15
$110	$10	–$5	$5
$120	$20	$5	–$5

Put Options

- Value at expiration (payoff)
  - a put option will be executed only if the exercise price is higher than the ongoing price of the stock
  - hence, the value of the option at expiration is

$$\text{Payoff to put holder} = \begin{cases} 0, & \text{if } S_T > X \\ X - S_T, & \text{if } S_T \leq X \end{cases}$$

where S_T is the "current price" of the stock, and X is the exercise price

Put Options (cont.)

- Moneyness
  - a put option is
    - *in the money* – if the exercise price is above the current price
    - *out the money* – if the exercise price is below the current price
    - *at the money* – if the exercise price is equal to the current price

Put Options (cont.)

- Profits
 - for the holder of the put option, the net profit is

    Profit = Value at expiration – Premium (P)

  - for the writer of the put option, the value at expiration and net profit are exactly the opposite those of the holder
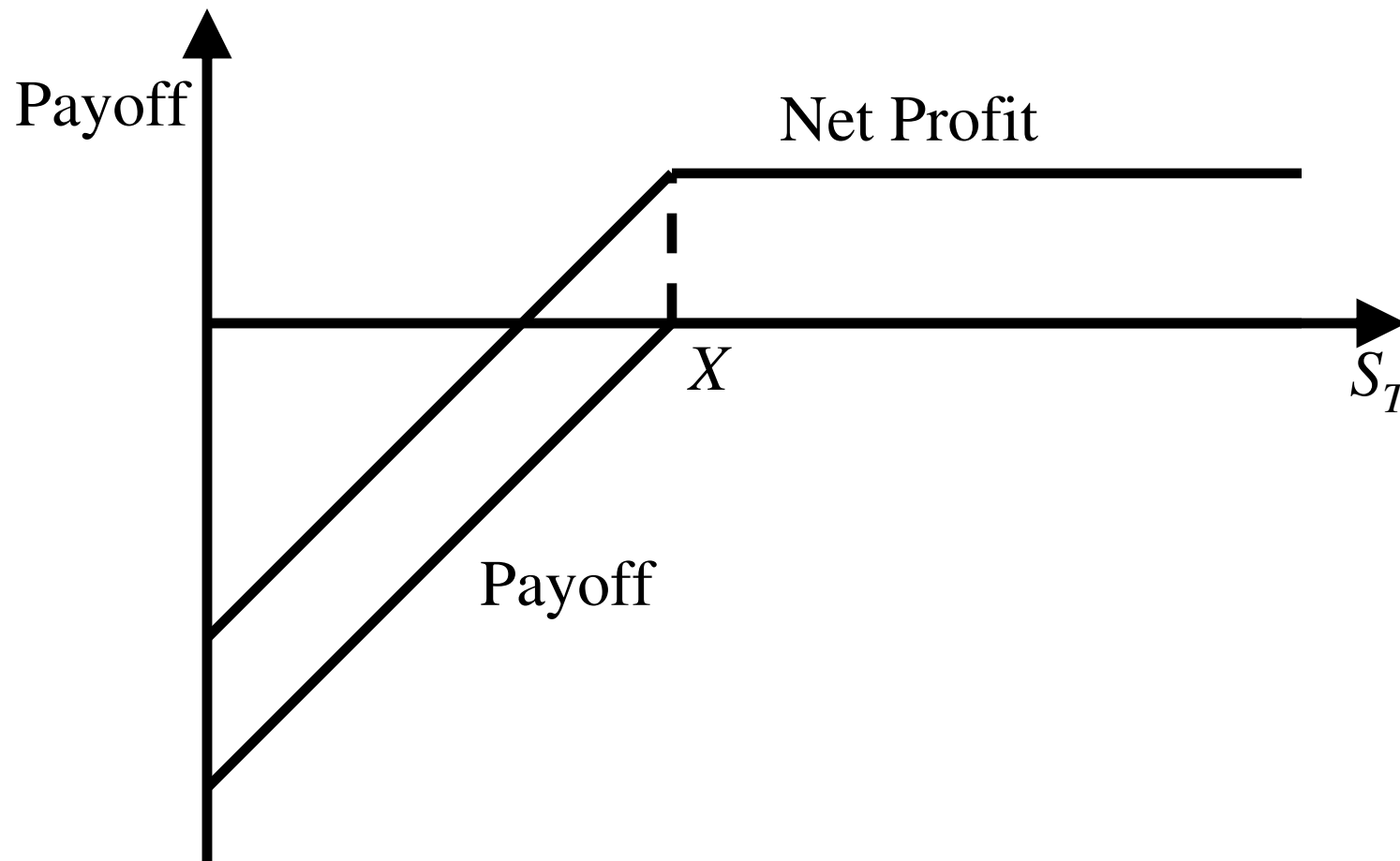
    Profit of writer = – Profit of holder

  - writing a *naked put* (i.e., a put option without an offsetting short position in the stock) exposes the investor to losses if the stock price falls

Put Options – Holder

Payoff

Payoff = Value at expiration

Net Profit

X

$\}$ P

S_T

Put Options – Writer

Payoff

Net Profit

X

S_T
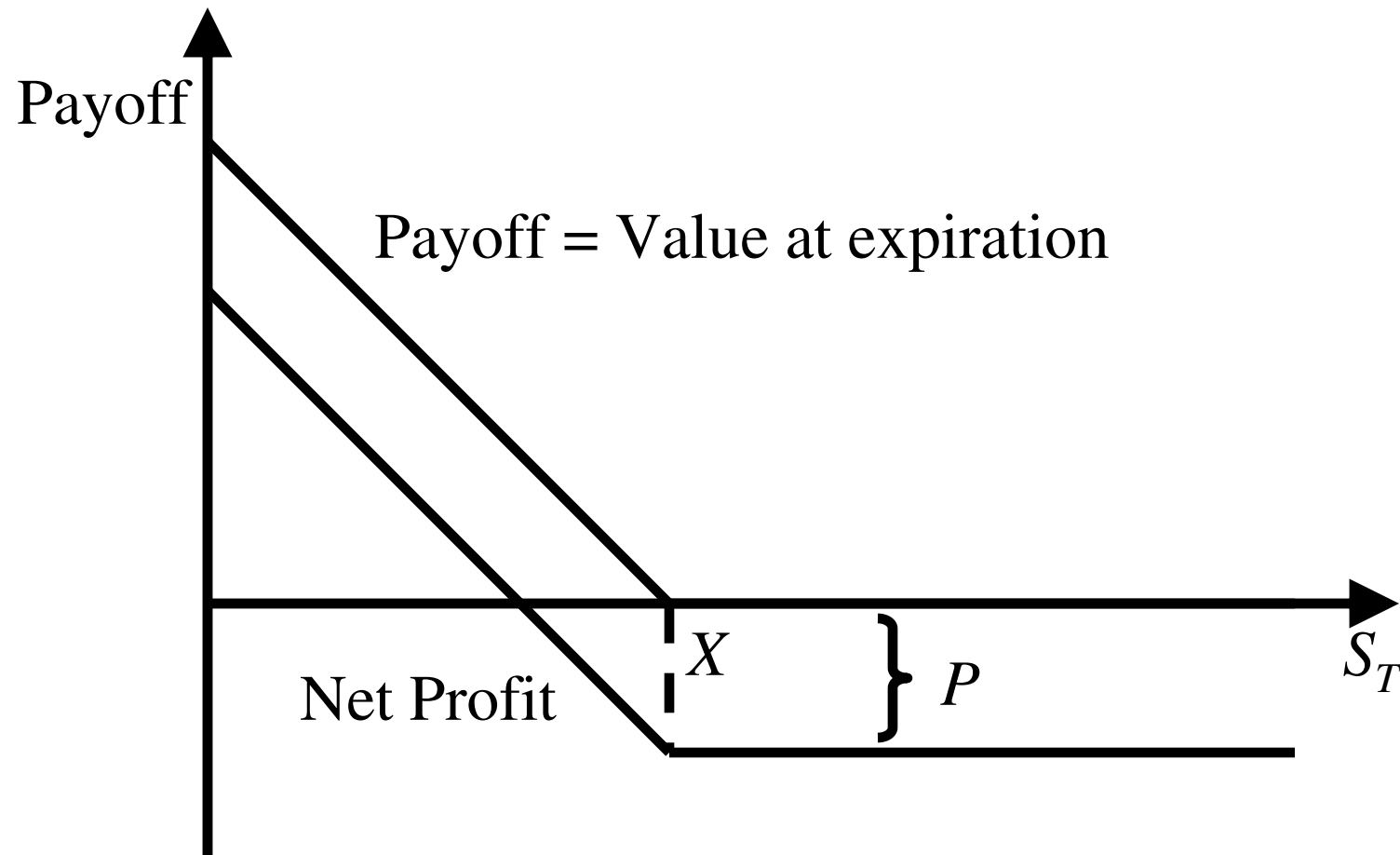
Payoff

Put Options – Example

- strike price: $X = \$100$
- premium: $15

Value of stock (S_T)	Payoff	Profit for holder	Profit for writer
$80	$20	$5	−$5
$90	$10	−$5	$5
$100	$0	−$15	$15
$110	$0	−$15	$15

Investments in Options

- purchasing call options or writing put options are *bullish* strategies (i.e., provide profits when stock prices increase)

- writing call options or purchasing put options are *bearish* strategies (i.e., provide profits when stock prices fall)

- as opposed to stock investments, investments in options provide better hedging opportunities

- also, remember that quotations and information about options are given *per share*, but an option contract is usually written for 100 shares
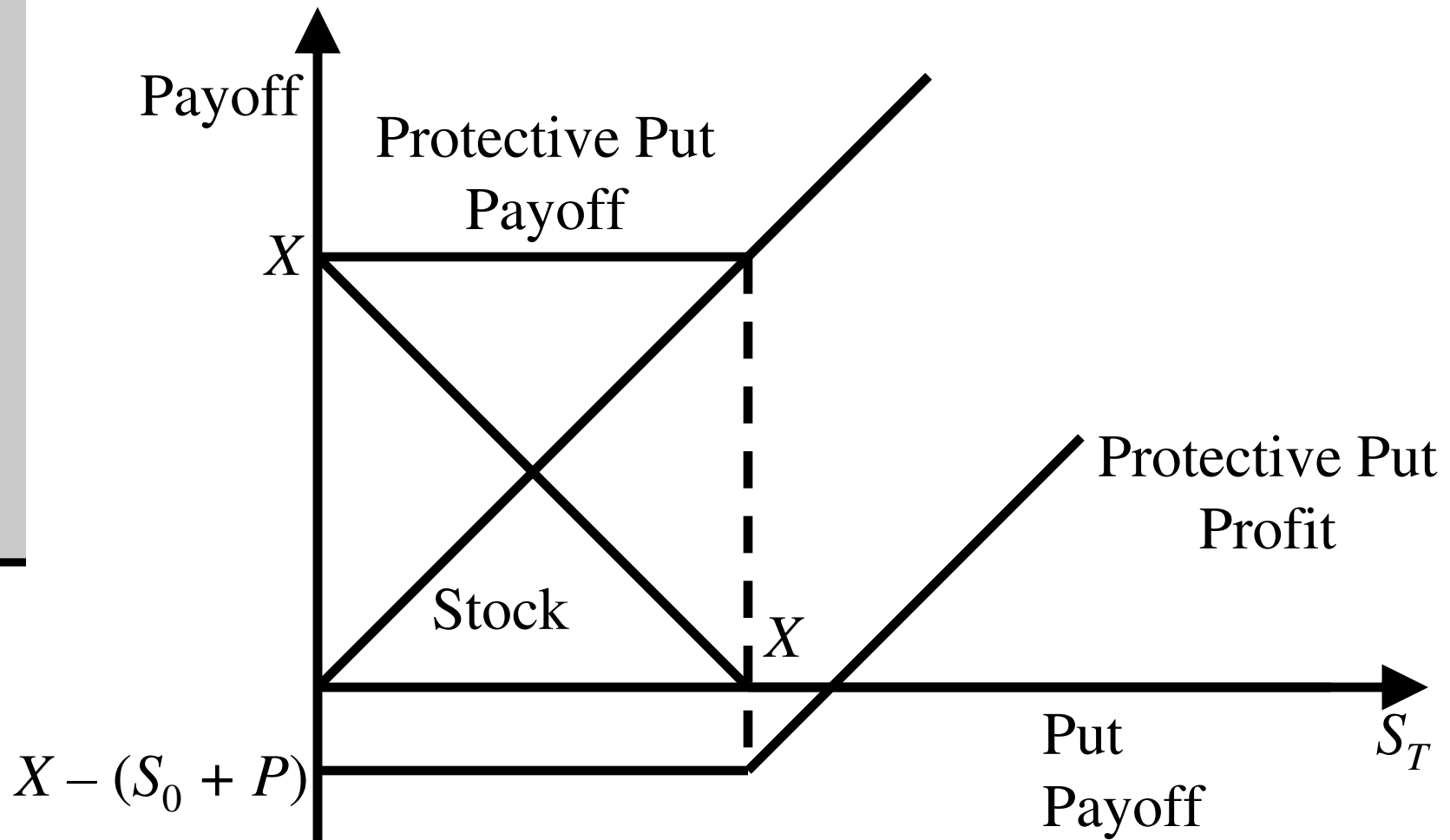
Option Strategies

- **Protective Put**
  - buy a stock and a put option on the stock at the same time
  - used to limit loss to a certain level (portfolio insurance) ➔ used for *risk management*
  - value of protective put at expiration:

	$S_T \leq X$	$S_T > X$
Payoff of stock	S_T	S_T
Payoff of put	$X - S_T$	0
Total payoff	X	S_T

Protective Put – Profit of Holder

Payoff

Protective Put
Payoff

X

Stock

X

Protective Put
Profit

Put
Payoff

S_T

$X - (S_0 + P)$

Option Strategies (cont.)

- Covered Call
  - buy a stock and sell a call option on the stock at the same time
  - used for downside protection, at the expense of giving up gain potential
  - value of protective put at expiration:

	$S_T \leq X$	$S_T > X$
Payoff of stock	S_T	S_T
Payoff of call	0	$-(S_T - X)$
Total payoff	S_T	X

Covered Call – Profit of Holder

Payoff

Stock

X

Covered Call
Payoff

Covered Call
Profit

X

S_T

$(X + C) - S_0$
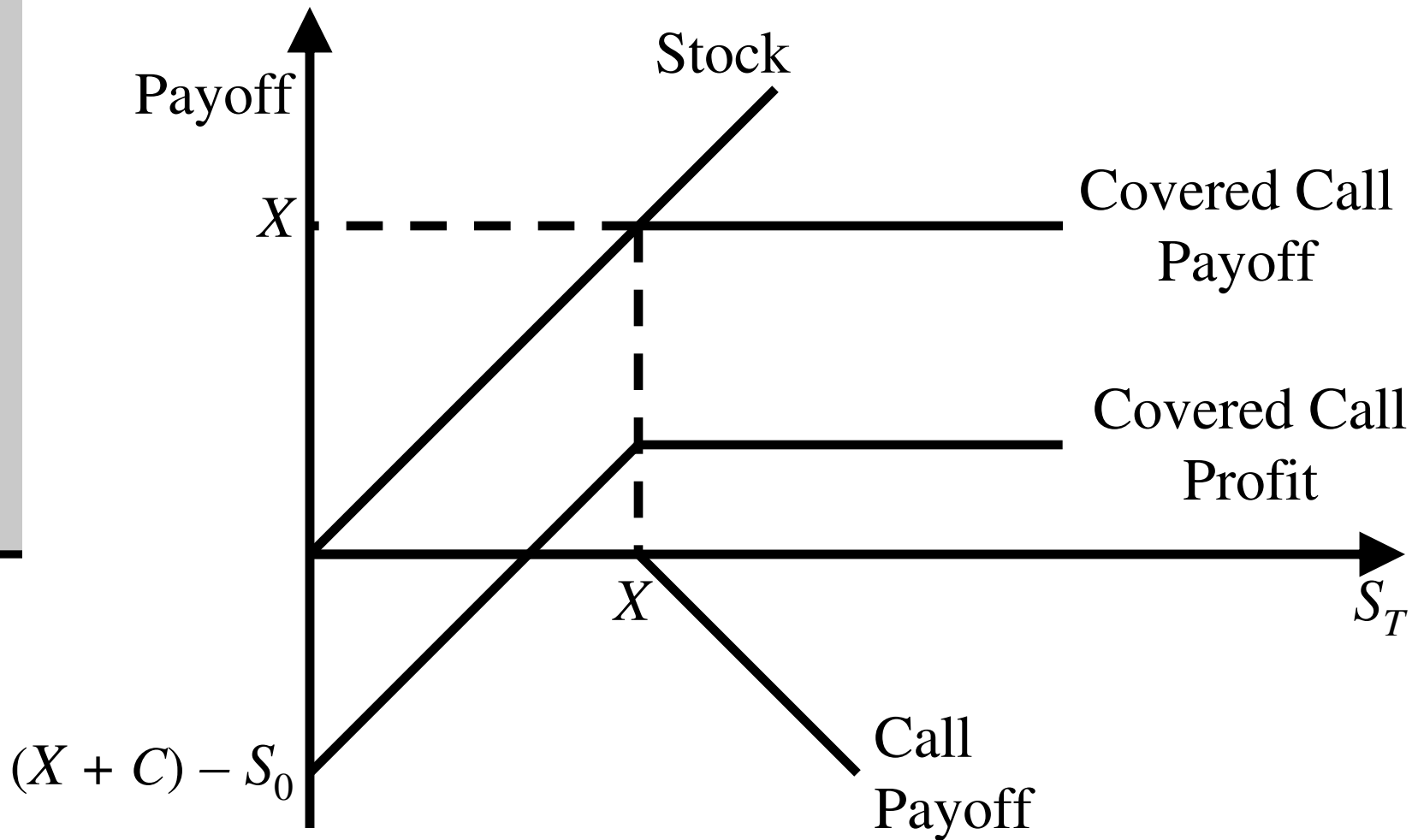
Call
Payoff

Option Strategies (cont.)
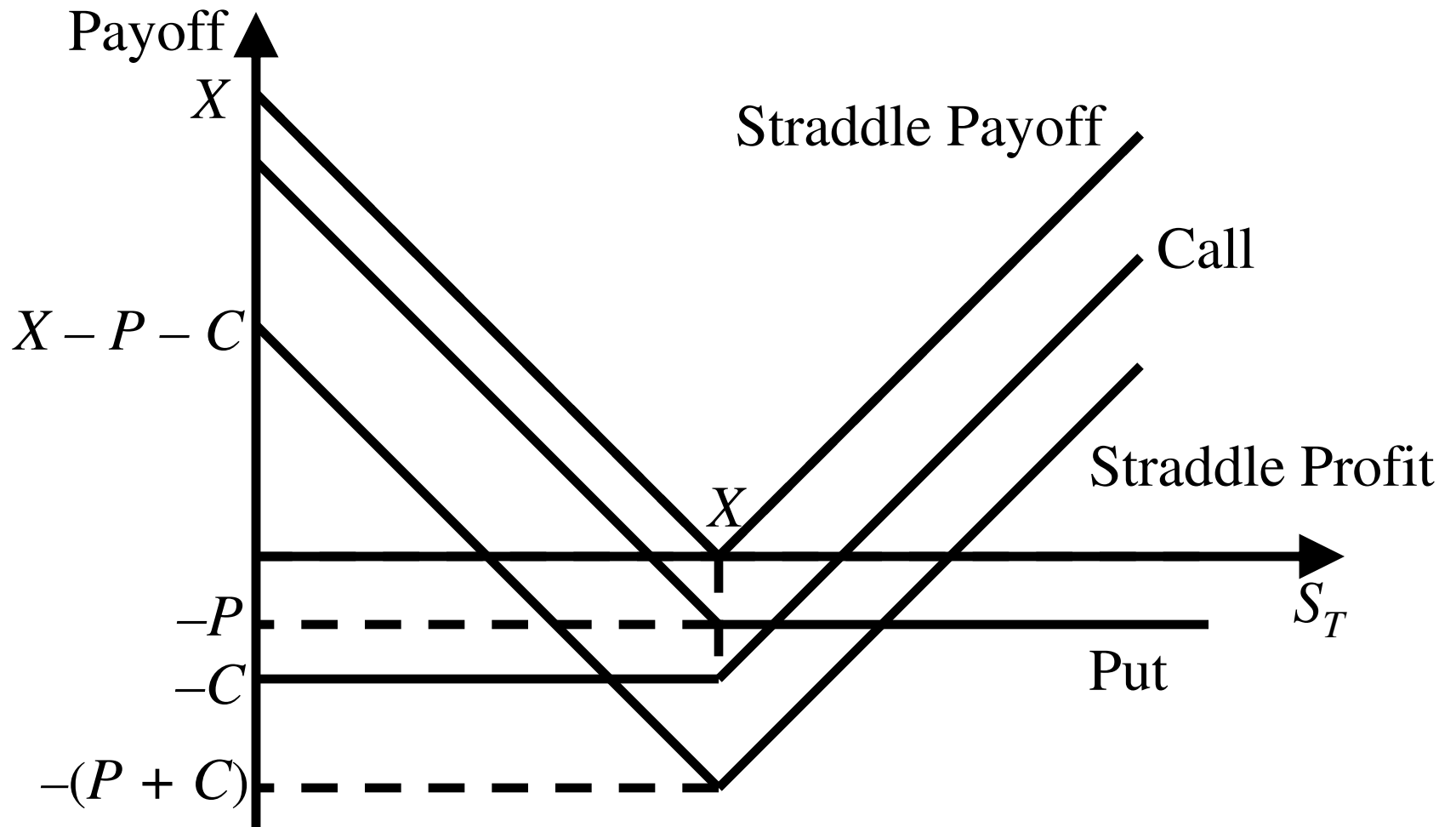
- **Straddle**
  - buy a call and a put option on the same stock, with same exercise price and same expiration date
  - used if price is believed to change, but direction of change is unknown (bet on volatility)
  - value of straddle at expiration:

	$S_T \leq X$	$S_T > X$
Payoff of call	0	$S_T - X$
Payoff of put	$-(S_T - X)$	0
Total payoff	$X - S_T$	$S_T - X$

Straddle – Profit of Holder
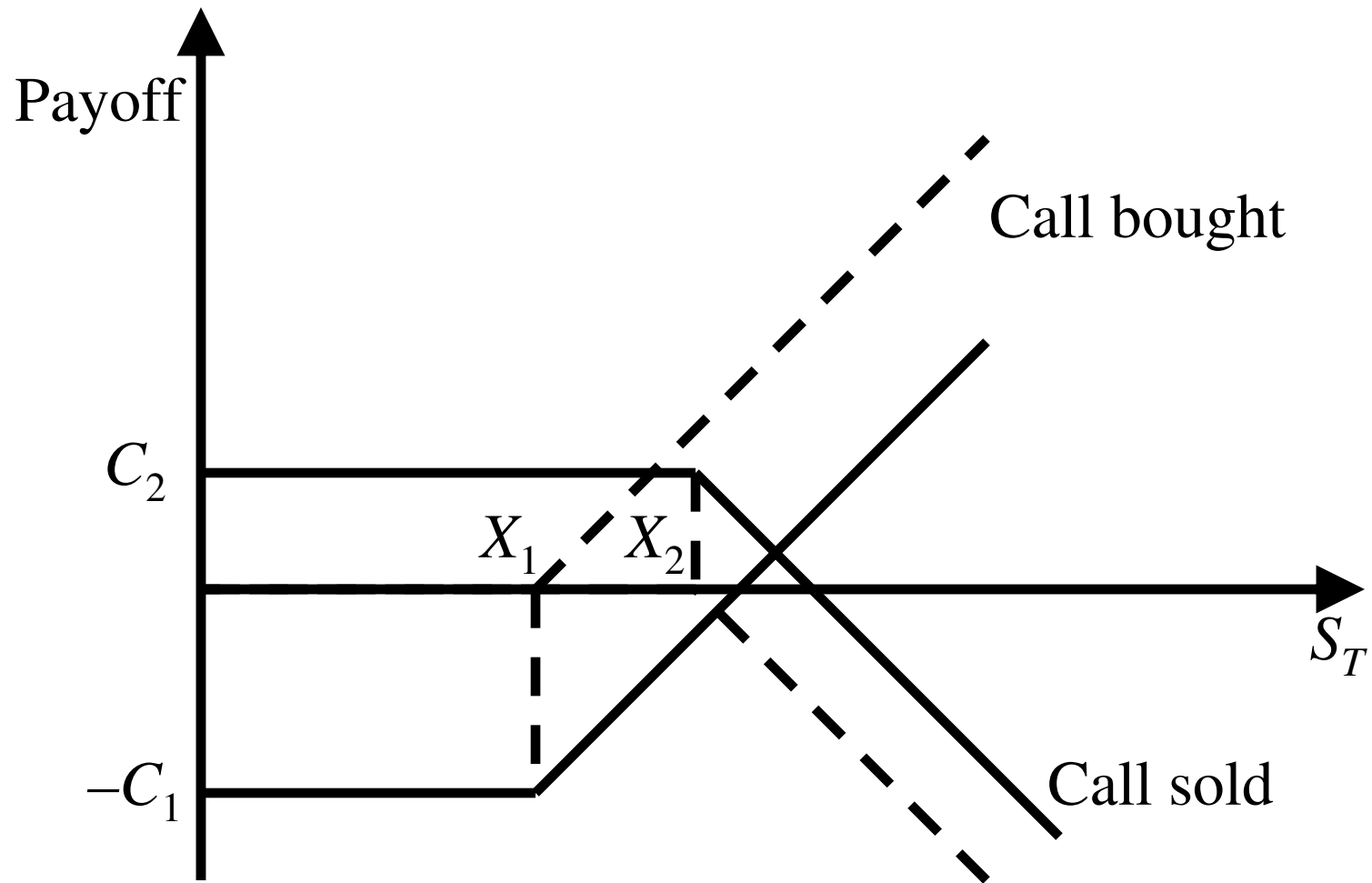
Option Strategies (cont.)

- **Spreads**
  - combinations of two or more call options (or put options) on the same stock, with different exercise prices or expiration dates
  - *money spread* = difference between options is exercise price
  - *time spread* = difference between options is expiration date

Example of Spread

- money spread: buy a call option with exercise price X_1 and sell a call option with exercise price $X_2 > X_1$
- bullish spread - payoff is either increased or unaffected by stock price increases
- value of spread at maturity:

	$S_T \leq X_1$	$X_1 < S_T \leq X_2$	$S_T > X_2$
Payoff of call 1	0	$S_T - X_1$	$S_T - X_1$
Payoff of call 2	0	0	$-(S_T - X_2)$
Total payoff	0	$S_T - X_1$	$X_2 - X_1$

Spread – Calls Profits and Payoffs

Payoff

Call bought

C_2

X_1 X_2

S_T

$-C_1$

Call sold

Spread – Profit of Holder
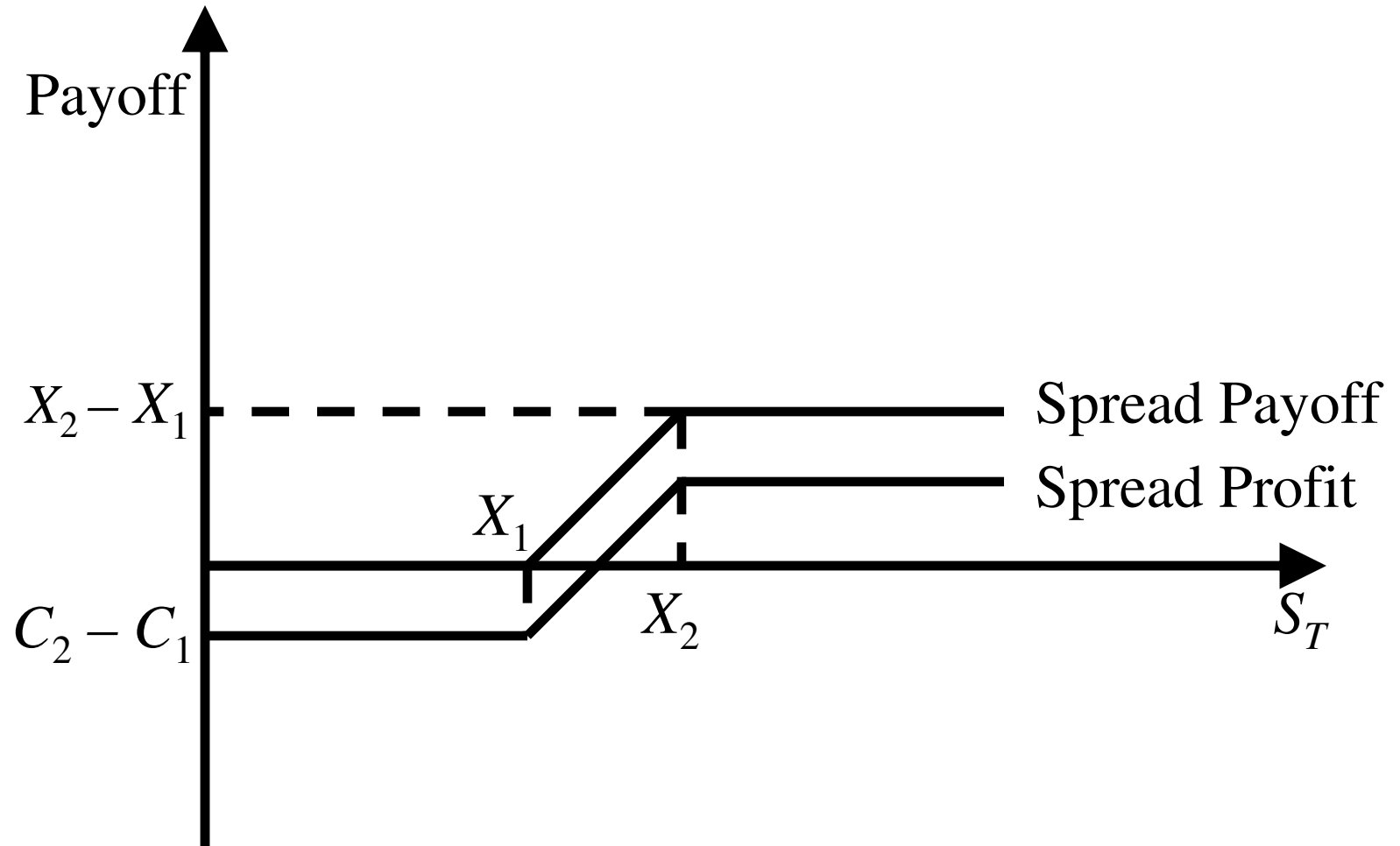
Option Strategies (cont.)

- Collar
  - options strategy that brackets the value of an existing portfolio between two bounds
  - used if a target wealth is set, and losses need to be limited
  - a lower bound can be placed by buying a put option ➔ need to pay a premium ➔ to recover the money paid for premium, write a call option (with higher exercise price)
  - the protection against downside risk is obtained by giving up the gain potential from price increases

Example of Collar

- you already hold stock, so buy a put option on the same stock with exercise price X_1 and sell a call option with exercise price $X_2 > X_1$
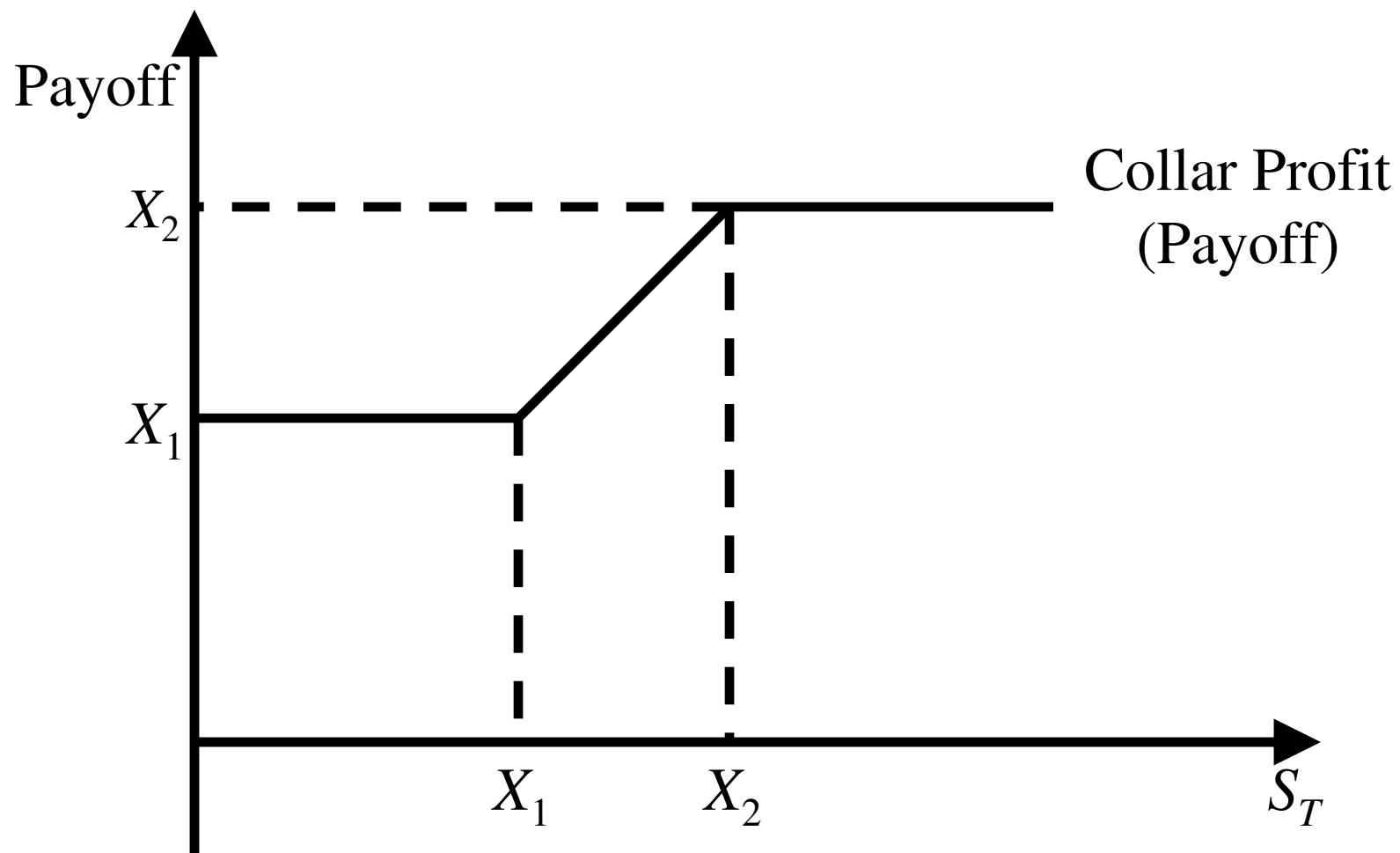- value of collar at maturity:

	$S_T \leq X_1$	$X_1 < S_T \leq X_2$	$S_T > X_2$
Payoff of stock	S_T	S_T	S_T
Payoff of put	$X_1 - S_T$	0	0
Payoff of call	0	0	$-(S_T - X_2)$
Total payoff	X_1	S_T	X_2

- notice that the payoff and the profit of the holder are equal, since the premiums cancel out

Collar – Calls Profits and Payoffs

Payoff — Stock — $C = P$ — Call sold — X_1 — X_2 — $-P = -C$ — Put bought — S_T
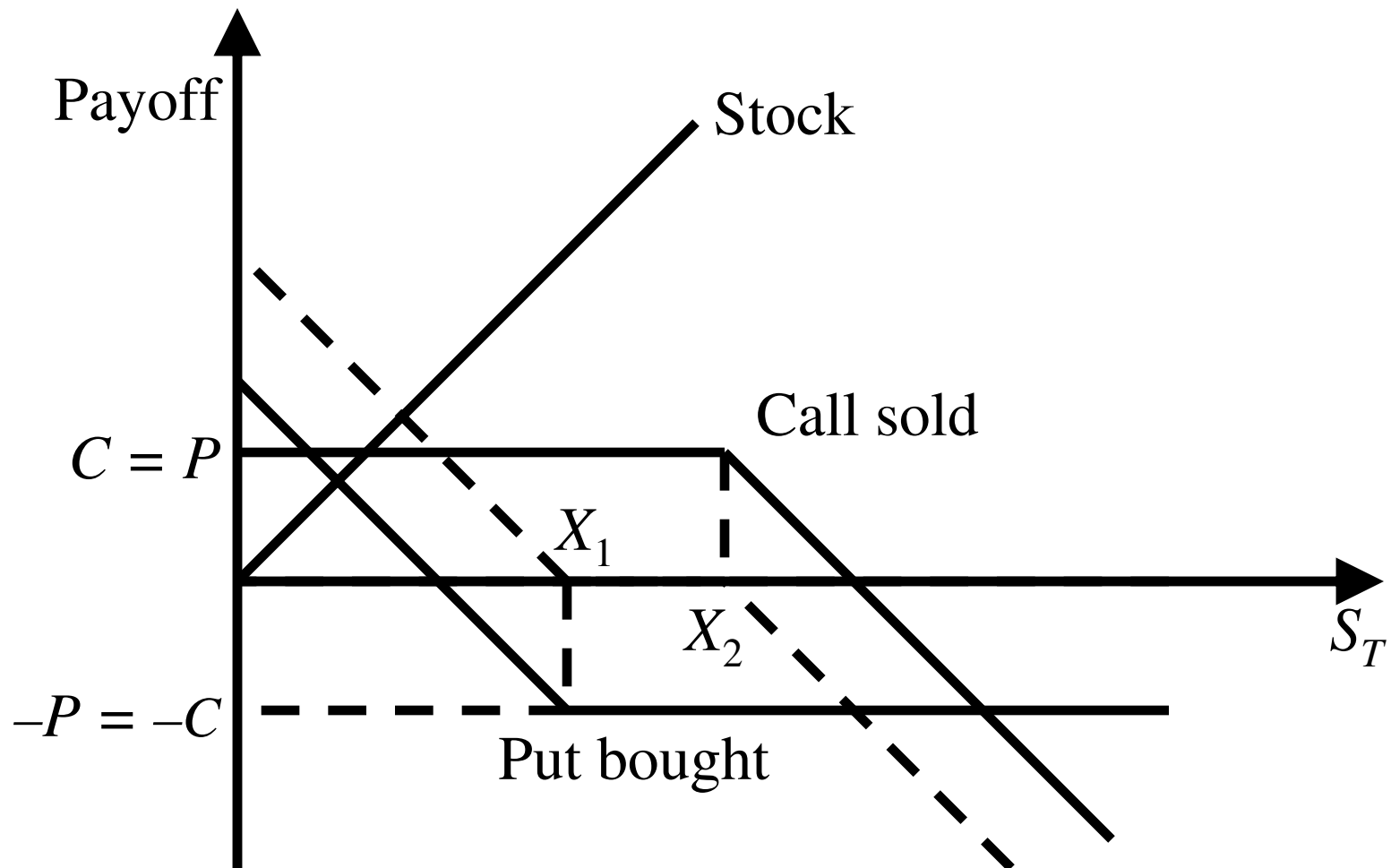
Collar – Profit of Holder

Collar Profit (Payoff)

Put-Call Parity Relationship

- an alternative strategy that provides the same type of protection as a protective put is a call with same expiration date and strike price X and a riskless bond with face value equal to X

- value of investment at maturity:

	$S_T \leq X$	$S_T > X$
Payoff of call	0	$S_T - X$
Payoff of bond	X	X
Total payoff	X	S_T

- this is exactly the same payoff pattern as the protective put

Put-Call Parity Relationship (cont.)

- arbitrage argument: if two investments always have the same value, they should have the same price
- the price of the protective put is the sum of put premium and stock price at time 0
- the price of the call + bond investment is the sum of the call premium and the present discounted value of the bond (i.e., of X)
- hence,

$$C + \frac{X}{(1+r_f)^T} = S_0 + P$$

Put-Call Parity Relationship (cont.)

- this relationship is called the *put-call parity theorem*

- notice that it applies only to European options, because they are exercised only at maturity

- it can be generalized to include dividends paid on the underlying stock:

$$P = C - S_0 + PV(X) + PV(Dividends)$$

- if it fails – arbitrage opportunity (create the other investment and profit from the price difference)

Exotic Options

- *Asian options* = payoff depends on average price of underlying asset during some portion of the life of the option

- *barrier options* = payoff depends not only on price at expiration, but also on whether the price has crossed through some barrier

- *lookback options* = payoffs depend in part on the min or max price during the life of the option

- *currency-translated options* = asset or exercise prices denominated in foreign currency

- *binary options* = payoffs depends on whether the price satisfies a certain condition or not